https://doi.org/10.36570/jduhs.2023.3.1903

JDUHS

ORIGINAL ARTICLE

Effect of High-Intensity Circuit Training versus Low-Intensity Interval Training on Functional Strength and Weight Efficacy in Overweight and Obese Young Females: A Randomized Clinical Trial

Huma Nayab,[1] Sarah Ehsan,[2] Farwah Batool,[3] Wajeeha Mahmood,[4] Tahir Mahmood[5]

1. Life Care Hospital, Lahore, Pakistan.
2. Riphah International University, Islamabad, Pakistan.
3. Pak Para Medical College, Chiniot, Pakistan.
4. Superior University, Lahore, Pakistan.
5. Rashid Latif Medical College Lahore, Pakistan.

Correspondence to: Tahir Mahmood, Email: tahirmahmoodphysio@gmail.com,ORCiD: 0000-0003-0175-5248

ABSTRACT

Objective: To compare the effects of high-intensity circuit training (HICT) versus low-intensity interval training (LIIT) on functional strength and weight efficacy in overweight and obese young females.

Methods: This randomized clinical trial was conducted at Ladies Club Gujranwala Cant, Pakistan from March 2021 to January 2022. Participants, aged 18-35, were randomly assigned to HICT or LIIT groups. Functional strength and weight efficacy were taken as outcomes and measured at baseline and the 8th week after the interventions. Leg levers, modified push-ups, squats, cordless skipping, and burpees were used to test functional strength. The Weight Efficacy Lifestyle Questionnaire Short Form (WELQS) was used to measure weight efficacy.

Results: Of total 34 of young females (17 in HICT and 17 in LIIT group), the median waist circumference was found significantly higher in the HICT group as compared to the LIIT group i.e., 39.0 (37.0 – 42.5) inches vs. 36.0 (33.0 – 38.5) inches (p-value 0.046) respectively. Similarly, the median hip measurement of the females was found significantly higher in the HICT group 45.0 (40.5 – 48.0) inches as compared to the LIIT group 41.0 (39.0 – 44.5) inches (p-value 0.029). Within-group comparison at baseline and after 8 weeks showed a significant median difference, with pushups, leg levers, burpees, left leg squats, right leg squats, skipping, and weight efficacy (p-value <0.001) respectively.

Conclusion: This study concludes that both HICT and LIIT improved functional strength and weight efficacy in overweight and obese young females. However, HICT led to significantly greater improvements in functional strength as compared to LIIT.

Keywords: Body Mass Index, Circuit Training, High Intensity Interval Training, Obesity, Overweight.

Clinical Trial Registry#: NCT04812340

INTRODUCTION

The unnecessary accumulation of fat in the body is regarded as being overweight and it increases the risk of different co-morbidities.[1] In the last few decades, the prevalence of obesity has increased and has become a public health challenge for the world and healthcare providers. The individuals, who are obese in their childhood and adolescence age, mostly remain the same during their adult age.[2] The main causes of being overweight and obese in all populations are a sedentary lifestyle, eating out, consuming fast food, and the availability of calorie-rich food at very low prices.[3] A study suggested that different populations have sustained obesity due to many behavioral, social, and community-level factors.[4] Factors such as the number of mealtimes per day, the duration of the interval between two meals and the quality of the products used in meals have been found to be responsible for obesity.[5,6]

The prevalence of obesity among young adults according to the national estimates is 60.03%.[7] Literature has shown that the prevalence of obesity in young adults is one kilogram per year lower in developed countries than in under-developed countries.[7] In the last four decades, obesity and overweight have increased but still, females are more prone to become overweight and obese than males with a prevalence ratio of 40:39 respectively.[8] Another study reported a high prevalence of obesity among adults and childhood.[9] The overweight and obesity can be reduced by improving the quality of life, daily physical activity, and physical and mental health. Many

interventions such as medication, lifestyle modification, different programs for weight loss, and surgery are used to treat overweight and obesity.[10] In high-intensity circuit training (HICT), the exercise bouts of short to long periods with high intensity are performed with a rest period between the exercise bouts.[11] There are several advantages of low-intensity aerobic exercise training (LIIT) such as an increase in the number of oxidative enzymes, glycogen, and angiogenesis, increase in muscle bulk and muscle strength.[12]

HICT and LIIT may be effective exercises to improve functional strength and quality of life, but it is unclear which intervention plan is most effective. We assumed and hypothesized that HICT and LIIT would be effective in overweight and obese young females to improve functional strength and weight efficacy. We aimed to compare the effects of HICT versus LIIT on functional strength and weight efficacy in overweight and obese young females. Investigating the comparative effects of both forms of exercise is important since adherence to the intervention is a major concern among overweight and obese patients. The growing epidemic of obesity and the limited success rate of traditional methods in the long term make it imperative to explore different and more effective forms of strategies. Exercise can be the best intervention that has less risk of injury, low cost, is easily accessible to all individuals, and can used as an alternative to medications.

METHODS

This randomized clinical trial was conducted at Ladies Club Gujranwala Cant, Pakistan from March 2021 to January 2022. Before the data collection, approval was sought from the ethical review committee of Riphah International University, Islamabad, Pakistan. The trial was registered at clinicaltrials.gov (Trial Registry No. NCT04812340). After getting informed consent, participants were randomly allocated into groups A and B using the lottery method.

The sample size was calculated using Open Epi-Tool with the mean physical fitness of sit-and-reach 13.05 ± 7.26 in group 1 and 20.83 ± 8.44[13] in group 2, confidence interval 95%, power of study 80% and ratio of sample size Group2/Group1 was 1. The sample size was estimated to be 34, i.e., 17 in each group. The eligible study participants were in the 18 to 35-year age group, with body mass index (BMI) >25 kg/m^2 and not engaged in routine exercise programs in the last 6 months.[1] The BMI of an adult from 25- 29.9 is considered overweight and more than 30 is considered as obesity.[14] Those with uncontrolled diabetes, thyroid disease, arthritis, cardiac diseases, asthma, hypertension, and recent trauma were excluded from the study, while females who were using weight loss products, or were pregnant were also excluded from the study. (Figure 1)

The study was conducted according to CONSORT guidelines, where subjects were screened and randomly allocated to two groups. Allocation was done through concealed envelopes, where data was hidden from participants and researchers and carried out while hiring a research assistant who was not involved in further research. Group A was provided with HICT and group B was provided with LIIT. The intervention protocol for both groups consisted of three phases: 1) Warm-up, 2) HICT, or LIIT exercise program, 3) Cool down. The participants performed dynamic stretching during the warm-up period for 10 minutes and static stretching during the cool-down period for 10 minutes. The frequency of the exercises performed by both groups was three sessions per week according to available literature support.[13]

In weeks 1–4 group A-HICT received a 6 series program with a 3 min rest period, burpees , skipping, lunges, 1-legged squats, leg levers, and push-ups with a recovery time of 30 seconds between each type, with 75 min total time.[15] Group B-LIIT received 4 series (with 3 min rest period between series) with a total time of 90 min, with 10-min jogging + 30-seconds recovery and 5-min walking + 30-seconds recovery. In Week 5-8 group A received 3 series (with 3 min rest period between series with burpees, skipping, lunges, 1-legged squats, leg levers, and push-ups with 45 seconds and 30 seconds recovery time and a total time of 90 min and group B received 3 series (with 3 minutes rest period between series) with 20-min jogging + 30-seconds recovery and 10-min walking + 30-seconds recovery with the sum of treatment time of 120 min.[13,11]

The outcome measures were functional strength and weight efficacy. To check their functional strength, participants were instructed to perform the leg lever, modified push-up, 45° one-legged squats, and burpee as many times as they could in 1 min. Participants were instructed to perform a maximum number of cordless skipping in 30 seconds. All functional strength tests were separated by a 3-minute recovery period.[16] To check the body strength these tests are highly valid and reliable in healthy young adults.[17] The second outcome measure, weight efficacy, was measured using the weight efficacy lifestyle questionnaire short form (WELQS), which measures the confidence of the participants in their weight loss ability.[18] The score ranges from 0-no confidence to 10-very confident.[19] The

reliability and validity of this tool are very high and it can be used in research, clinical and educational fields.[20] This was a single-blind study where the outcome assessor was kept blinded. These tests were performed by both groups before starting the training program and again after the completion of an 8-week training program. All the ethical standards, including confidentiality, participants' identity, and their data were handled following the declaration of Helsinki.

Statistical Package for Social Sciences (SPSS) version 24 was used for statistical analysis. The normality of the data was checked through the Shapiro-Wilk test. The data were not normally distributed. The median and interquartile range were calculated for age, weight, height, BMI, waist, hip, and waist-hip ratio. Inferential statistics were explored using the Mann-Whitney U test for between-group comparison of functional strength, weight efficacy, and baseline characteristics. The Wilcoxon Signed Ranks test was used for within-group comparison of functional strength and weight efficacy. The p-value of ≤0.05 was considered as significant.

RESULTS

Out of the total of 34 young females, the overall median age was 26.0 (21.0 – 30.0) years. The median weight, height, BMI, waist circumference, hip, and waist-hip ratio were 75.2 (66.0 – 85.7) kg, 5.3 (5.17 – 5.5) feet, 27.7 (26.6 – 32.0) kg/m^2, 37.0 (34.0 – 39.2) inches, 41.0 (39.3 – 45.2) inch, and 0.9 (0.8 – 0.9) respectively.

Females were divided into two groups, with 17 (50.0%) females in the LIIT group and 17 (50.0%) in the HICT group. The median waist circumference of the females was found significantly higher in the HICT group as compared to the LIIT group i.e., 39.0 (37.0 – 42.5) inches vs. 36.0 (33.0 – 38.5) inches (p-value 0.046) respectively. Similarly, the median hip measurement of the females was found significantly higher in the HICT group 45.0 (40.5 – 48.0) inches as compared to the LIIT group 41.0 (39.0 – 44.5) inches (p-value 0.029) (Table 1).

Between-group comparison of functional strength and weight efficacy showed an insignificant median difference between the LIIT and HICT groups, with pushups (p-value 0.667), leg levers (p-value 0.248), burpees (p-value 0.333), left leg squat (p-value 0.469), right leg squat (p-value 0.783), skipping (p-value 0.756),

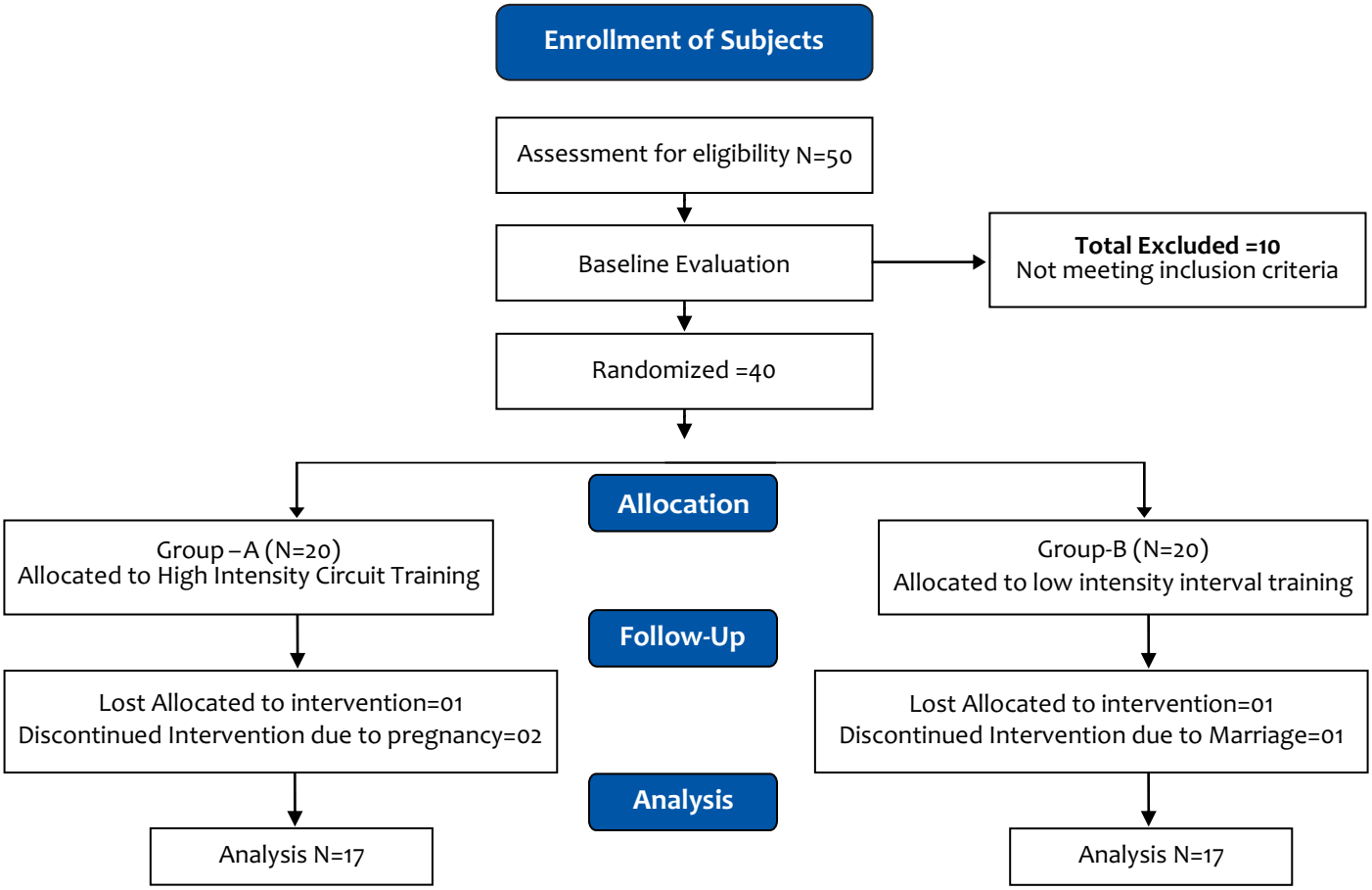

Figure 1: Flow chart showing subjects recruitment, follow up and analysis

and weight efficacy (p-value 0.836) all found to be insignificant factors (Table 2).

Within-group comparison at baseline and after 8 weeks showed a significant median difference, with pushups (p-value <0.001), leg levers (p-value <0.001), burpees (p-value <0.001), left leg squats (p-value <0.001), right leg squat (p-value <0.001), skipping (p-value <0.001), and weight efficacy (p-value <0.001) being significantly different between the two-time points (Table 3).

DISCUSSION

The main findings of this 8-week exercise plan of HICT or LIIT on function strength and weight efficacy in overweight and obese young females indicated that the number of push-ups, leg levers, burpees, 45-degree single-leg squats (left and right), and skipping were improved in the HICT group. The weight efficacy was not improved significantly between the HICT or LIIT groups. Our alternative hypothesis proved that HICT and LIIT were effective in overweight and obese young females for improving functional strength but had non-significant effects on weight efficacy, and none of the training types was dominant over the other.

A previous study reported that the high-intensity-circuit training shows more positive results in increasing maximum oxygen uptake, and both HICT and LIIT interventions can improve functional strength, and maximum oxygen consumption with resultant improvements in the quality of life .[13] Kim *et al*. reported that circuit training considerably reduces body fat, body weight, and body mass index compared with the

Table 1: Comparison of HICT and LIIT with demographic characteristics (n= 34)

Demographic Variables	LIIT (n= 17) Median (IQR)	HICT (n= 17) Median (IQR)	p-value
Age (years)	26.0 (21.0 – 29.0)	27.0 (21.5 – 31.5)	0.427
Weight (kg)	68.0 (65.0 – 82.0)	78.0 (67.1 – 92.0)	0.234
Height (feet)	5.3 (5.2 – 5.4)	5.3 (5.1 – 5.7)	0.848
BMI (kg/m^2)	26.8 (25.8 – 31.3)	29.5 (27.2 – 32.4)	0.054
Waist (inches)	36.0 (33.0 – 38.5)	39.0 (37.0 – 42.5)	0.046*
Hip (inch)	41.0 (39.0 – 44.5)	45.0 (40.5 – 48.0)	0.029*
Waist to Rip Ratio	0.89 (0.82 – 0.96)	0.90 (0.82 – 0.92)	0.604

- IQR: Inter Quartile Range, Kg: Kilogram, m^2 : meter square, HICT: High-Intensity Circuit Training, LIIT: Low-Intensity Interval Training

Mann–Whitney U test applied, *p-value ≤ 0.05

Table 2: Between group comparison of functional strength and weight efficacy after intervention (n= 34)

Outcome	LIIT (n= 17) Median (IQR)	HICT (n= 17) Median (IQR)	p-value
Functional Strength			
Pushups	32.0 (15.5 – 42.5)	32.0 (21.0 – 44.5)	0.667
Leg Levers	25.0 (12.0 – 32.0)	31.0 (19.0 – 34.5)	0.248
Burpees	12.0 (10.0 – 15.0)	10.0 (7.0 – 16.5)	0.333
Left Leg Squat	35.0 (21.0 – 45.0)	42.0 (19.0 – 48.5)	0.469
Right Leg Squat	35.0 (21.5 – 46.0)	40.0 (19.0 – 49.5)	0.783
Skipping	44.0 (21.0 – 70.0)	55.0 (21.0 – 70.0)	0.756
Weigh Efficacy	61.0 (49.5 – 64.0)	57.0 (52.5 – 67.5)	0.836

- IQR: Inter Quartile Range, HICT: High-Intensity Circuit Training, LIIT: Low-Intensity Interval Training

Mann–Whitney U test applied, *p-value ≤ 0.05

Table 3: Pre and post within group comparison of functional strength and weight efficacy (n= 34)

Outcome	Groups	Intervention	Median (IQR)	p-value
Pushups	**LIIT (n= 17)**	Baseline	26.0 (9.0 – 33.0)	<0.001*
		After 08 weeks	32.0 (15.5 – 42.5)	
	HICT (n= 17)	Baseline	27.0 (17.0 – 36.5)	<0.001*
		After 08 weeks	32.0 (21.0 – 44.5)	
Leg Levers	**LIIT (n= 17)**	Baseline	18.0 (10.0 – 26.0)	<0.001*
		After 08 weeks	25.0 (12.0 – 32.0)	
	HICT (n= 17)	Baseline	15.0 (14.0 – 29.0)	<0.001*
		After 08 weeks	31.0 (19.0 – 34.5)	
Burpees	**LIIT (n= 17)**	Baseline	8.0 (5.0 – 9.5)	<0.001*
		After 08 weeks	12.0 (10.0 – 15.0)	
	HICT (n= 17)	Baseline	8.0 (3.5 – 9.0)	<0.001*
		After 08 weeks	10.0 (7.0 – 16.5)	
Left Leg Squat	**LIIT (n= 17)**	Baseline	20.0 (15.0 – 37.0)	<0.001*
		After 08 weeks	35.0 (21.0 – 45.0)	
	HICT (n= 17)	Baseline	32.0 (11.0 – 36.5)	<0.001*
		After 08 weeks	42.0 (19.0 – 48.5)	
Right Leg Squat	**LIIT (n= 17)**	Baseline	20.0 (15.0 – 35.5)	<0.001*
		After 08 weeks	35.0 (21.5 – 46.0)	
	HICT (n= 17)	Baseline	30.0 (12.5 – 38.5)	<0.001*
		After 08 weeks	40.0 (19.0 – 49.5)	
Skipping	**LIIT (n= 17)**	Baseline	34.0 (15.0 – 40.0)	<0.001*
		After 08 weeks	44.0 (21.0 – 70.0)	
	HICT (n= 17)	Baseline	29.0 (16.0 – 51.0)	<0.001*
		After 08 weeks	55.0 (21.0 – 70.0)	
Weigh Efficacy	**LIIT (n= 17)**	Baseline	40.0 (19.0 – 48.0)	<0.001*
		After 08 weeks	61.0 (49.5 – 64.0)	
	HICT (n= 17)	Baseline	41.0 (30.0 – 53.0)	<0.001*
		After 08 weeks	57.0 (52.5 – 67.5)	

- IQR: Inter Quartile Range, HICT: High-Intensity Circuit Training, LIIT: Low-Intensity Interval Training
Wilcoxon Signed Ranks test applied, *p-value ≤ 0.05

control group.[13] They also found that all other risk factors of metabolic syndromes were also reduced in the circuit training group, suggesting that metabolic diseases can be inhibited and functional fitness can be enhanced with circuit training.[13] This study reports the significant effect of circuit training in improving functional fitness . The left leg squats showed significant results, indicating that both techniques had improved outcomes but there were significant effects of HICT compared to LITT.[13] The current study is HICT versus LIIT in young females showed no significant improvement in weight loss self-efficacy. Schulz *et al*. in their study found that watching physical training videos does not improve physical activity but improves weight loss self-efficacy.[18]

The health-related exercises and self-directed exercises can have a positive relationship with eating habits and body image. However, literature also suggests that exercises for weight loss and bodybuilding can have a negative relation with eating habits and body image.[19] LIIT comprises of different intervals of low and high intensity with a short duration for recovery and can preserve normal oxygen supply to cardiac muscles and increase heart efficacy. It can also reduce the incidence of diastolic dysfunction.[21] The current study shows that both exercise interventions had significant differences when compared across the group at baseline and post intervention, but no significant result was found for outcomes when compared between the groups. Regarding effectiveness, females with a sedentary lifestyle with great risk for established musculoskeletal and cardiac diseases, can reduce their risk by low intense exercise programs.[22] Literature suggests that HICT and moderate-intensity continuous training (MICT) both are great interventions for controlling diastolic blood pressure and VO^2 max and these interventions should be used as an exercise plan by middle and old-aged females.[23]

We acknowledge the limitations of this study. The sample size was small and the duration was short. The sample was collected only from a single setting and only short-term effects of the interventions were investigated. Further high-quality studies should be conducted to establish the long-term effect of the current interventional protocol on functional strength and weight efficacy. We recommend study with large sample size, in multiple settings, to study the effect of the intervention plan on functional strength and weight efficacy with an accurate picture of the study population. A combination of dietary intervention with these physical training interventions can also be used to further evaluate effect on functional strength and weight efficacy.

CONCLUSION

In summary, our study found that both high-intensity circuit training (HICT) and low-intensity interval training (LIIT) were effective in enhancing functional strength and weight efficacy in overweight and obese young females. However, it is noteworthy that HICT led to significantly greater improvements in functional strength compared to LIIT.

ETHICAL APPROVAL: This study obtained ethical approval from Riphah International University, Islamabad, Pakistan (RIPHAH/RCRS/REC/Letter-00924).

AUTHORS' CONTRIBUTIONS: HN: Made substantial contributions to the conception or design of the work. SE: Analysis and interpretation of data, methodology. FB: Statistical work, literature addition, editing. WM: Discussion writing, Important intellectual and critical revision. TM: Drafted the work or revised it critically for important intellectual content, editing final approval and guarantor. All authors approved the final version of the manuscript to be published.

CONFLICT OF INTEREST: The authors declared no conflict of interest.

FUNDING: None

Acknowledgements: We are thankful to Dr. Hira Jabeen at Riphah International University Lahore and Administration of the Ladies Club Gujranwala Cantonment for their support and facilitation during the data collection.

Received: July 19, 2023
Accepted: November 05, 2023

REFERENCES

1. Purnell JQ. Definitions, classification, and epidemiology of obesity. In: Feingold KR, Anawalt B, Blackman MR, Boyce A, Chrousos G, Corpas E, et al, editors. Endotext [Internet]. South Dartmouth (MA): MDText.com, Inc.; 2000.
2. Sand AS, Furberg AS, Lian OS, Nielsen CS, Pettersen G, Winther A, et al. Cross-sectional study of the differences between measured, perceived and desired body size and their relations with self-perceived health in young adults: The Tromso Study - Fit Futures 2. Scand J Public Health 2017; 45:322-30.

doi:10.1177/1403494817690941
3. Shrestha S, Asthanee S, Karmaharya BM, Subedi S, Koju R. Perception of obesity and overweight among adults living in suburban Nepal: a qualitative study. BMJ Open 2021; 11:e043719. doi:10.1136/bmjopen-2020-043719
4. Okop KJ, Mukumbang FC, Mathole T, Levitt N, Puoane T. Perceptions of body size, obesity threat and the willingness to lose weight among black South African adults: a qualitative study. BMC Public Health 2016; 16:365. doi:10.1186/s12889-016-3028-7
5. Zalewska M, Maciorkowska E. Selected nutritional habits of teenagers associated with overweight and obesity. PeerJ 2017; 5:e3681. doi:10.7717/peerj.3681
6. Moser JS, Galindo-Fraga A, Ortiz-Hernandez AA, Gu W, Hunsberger S, Galan-Herrera JF, et al. Underweight, overweight, and obesity as independent risk factors for hospitalization in adults and children from influenza and other respiratory viruses. Influenza Other Respir Viruses 2019; 13:3-9. doi:10.1111/irv.12618
7. Poobalan A, Aucott L. Obesity among young adults in developing countries: A systematic overview. Curr Obes Rep 2016; 5:2-13. doi:10.1007/s13679-016-0187-x
8. Kumanyika S, Dietz WH. Solving population-wide obesity - progress and future prospects. N Engl J Med 2020; 383:2197-200. doi:10.1056/NEJMp2029646
9. Hales CM, Carroll MD, Fryar CD, Ogden CL. Prevalence of obesity among adults and youth: united states, 2015-2016. NCHS Data Brief 2017; 288:1-8.
10. Sun X, Li P, Yang X, Li W, Qiu X, Zhu S. From genetics and epigenetics to the future of precision treatment for obesity. Gastroenterol Rep (Oxf) 2017; 5:266-70. doi:10.1093/gastro/gox033
11. Sperlich B, Wallmann-Sperlich B, Zinner C, Von Stauffenberg V, Losert H, Holmberg HC. Functional high-intensity circuit training improves body composition, peak oxygen uptake, strength, and alters certain dimensions of quality of life in overweight women. Front Physiol 2017; 8:172. doi:10.3389/fphys.2017.00172
12. de Oliveira MF, Caputo F, Corvino RB, Denadai BS. Short-term low-intensity blood flow restricted interval training improves both aerobic fitness and muscle strength. Scand J Med Sci Sports 2016; 26:1017-25. doi: 10.1111/sms.12540
13. Kim JW, Ko YC, Seo TB, Kim YP. Effect of circuit training on body composition, physical fitness, and metabolic syndrome risk factors in obese female college students. J Exerc Rehabil 2018; 14:460-5. doi:10.12965/jer.1836194.097
14. Centers for disease control and prevention. defining adult overweight & obesity. Adult body mass index : Updated June 7, 2021. Cited 05 sepember, 2023. Avilable from: www.cdc.gov/ obesity/adult/defining.html
15. Balaji E. Effects of functional high intensity interval training circuit on peak oxygen consumption in sedentary college men. BNJPEES 2021: 12: 4:1-5
16. Sperlich B, Hahn LS, Edel A, Behr T, Helmprobst J, Leppich R, et al. A 4-Week intervention involving mobile-based daily 6-minute micro-sessions of functional high-intensity circuit training improves strength and quality of life, but not cardio-respiratory fitness of young untrained adults. Front Physiol 2018; 9:423. doi:10.3389/fphys.2018.00423
17 Ojeda A H, Maliqueo S G, Barahona-Fuentes G. Validity and reliability of the Muscular Fitness Test to evaluate body strength-resistance. Apunts Sports Med 2020; 55:128-36. doi:10.1016/j.apunsm.2020.08.002
18. Schulz BR, McDonald MJ. Weight loss self-efficacy and modelled behaviour: gaining competence through example. Can J Couns Psychother 2011; 45:53-67.
19. Singh H, Mun V, Barua A, Ali S, Swee W. Application and validation of the weight efficacy lifestyle (WEL) questionnaire among type 2 diabetes mellitus patients in Malaysia. Mal J Nutr 2018; 24:427-40.
20. Navidian A. Reliability and validity of the weight efficacy lifestyle questionnaire in overweight and obese individuals. Int J Behav Sci 2009; 3:217-22.
21. Marshall KD, Muller BN, Krenz M, Hanft LM, McDonald KS, Dellsperger KC, et al. Heart failure with preserved ejection fraction: chronic low-intensity interval exercise training preserves myocardial O2 balance and diastolic function. J Appl Physiol 2013; 114:131-47. doi:10.1152/japplphysiol.01059.2012
22. Rohmansyah NA, Ka Praja R, Phanpheng Y, Hiruntrakul A. High-Intensity Interval Training Versus Moderate-Intensity Continuous Training for Improving Physical Health in Elderly Women. Inquiry; 2023 ;60: 469580231-172870. doi: 10.1177/00469580231172870.
23. Ballesta-Garcia I, Martinez-Gonzalez-Moro I, Ramos-Campo DJ, Carrasco-Poyatos M. High-intensity interval circuit training versus moderate-intensity continuous training on cardiorespiratory fitness in middle-aged and older women: A randomized controlled trial. Int J Environ Res Public Health 2020; 17:1805. doi:10.3390/ijerph17051805